Horizon for Transition Metal Phosphides and Sulfides in Catalysis

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Heterogeneous catalysis is essential to most industrial chemical processes. However, these processes are often not efficient or selective enough and typically use rare noble metals as catalysts. Improving the sustainability of existing processes will rely on the development of innovative control elements in catalysis and the adoption of earth-abundant materials as catalysts. Earth-abundant transition metal phosphides and sulfides have recently emerged as promising materials in some catalytic applications,[1-3] but these materials are underexplored for catalysis. New discoveries are hampered by a limited understanding of the interfacial chemistry that directs the catalytic properties of these materials. Furthermore, while there are a range of sophisticated methods available to tune the catalytic properties of noble metals,[4,5] such strategies are only just emerging for phosphides and sulfides.[6-8]

Our research focuses on advancing the use of transition metal phosphides and sulfides in catalytic applications and developing new strategies for controlling catalytic processes at the surface.[7-10] In this talk, I will discuss our recent progress in the area. We use molecular strategies to develop a better understanding of the surface fundamentals that govern the catalysis of phosphides and sulfides. Based on our fundamental insights, we tune the catalytic properties of these materials by chemical surface modification strategies. In addition, few reports suggested that catalytic reactions can be tuned by application of an electric field.[11, 12] However, this approach is not more generally applied because of the complexity of electric field effects. I will discuss our efforts to understand the influence of electric fields on interfacial chemistry and how this could be used to steer heterogeneous catalysis.

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